Analysis Of The Labor Supply In Information Technology Occupations

Provided to the 21st Century Workforce Commission

Meeting in Cupertino, California

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See "California's High-Tech Industries and Information Technology Occupations (August 2003)" for updated information.

http://www.calmis.ca.gov/SpecialReports/HighTech2003.pdf

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INTRODUCTION

This report represents the Employment Development Department's (EDD) analysis of the labor market for information technology (IT) occupations in California. The EDD generally refers to this as high technology employment, recognizing that this review only covers information technology and does not include biotechnology, medical technology, or other technologically rich industry areas.

The Information Technology Analysis covers two general areas:

- Characteristics and recent trends of the information technology workforce in the U.S. and California including projected employment in 11 high technology industries in California, and in eight information technology occupations.

- Evidence of supply/demand problems as demonstrated by 1) annual earnings growth in the high technology industries; and 2) employer survey data on the difficulty in hiring workers in several information technology occupations.

- Finally, a summary of skills required for the key high technology occupations is provided.

Our analysis is based on data collected by the U.S. Bureau of Labor Statistics, EDD's Labor Market Information Division, and EDD's partners in 38 local areas covering all of California.

HIGH TECHNOLOGY INDUSTRIES

There are 11 California high technology industry groups where one can expect to find a substantial number of information technology workers.

These include the three aerospace manufacturing industries:

- Aircraft & parts,
- Missiles, spacecraft and parts, and
- Search and navigation equipment;

the four electronics manufacturing industries:

- Computer and office equipment,
- Electronic components,
- Measuring and control devices, and
- Communications equipment;

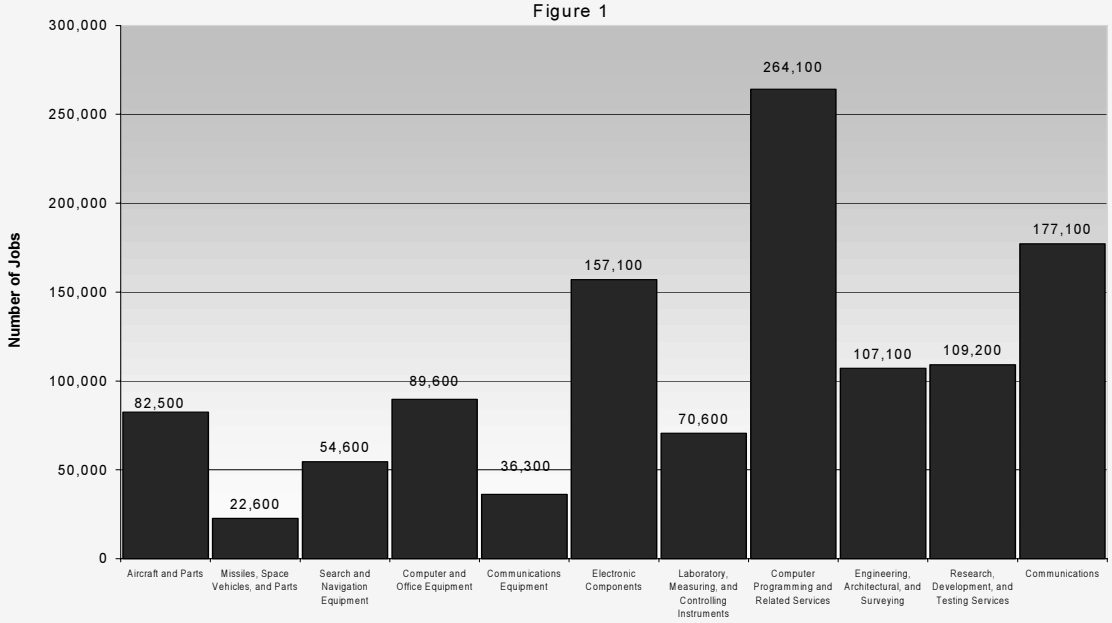
and four service sector industries:

- Communications services
- Computer programming and related services
- Engineering, architectural, and surveying services, and
- Research, development, and testing services.

Employment: In 1999, there were a total of 1,170,800 California jobs in these high technology industries,

Employment in California High Technology Industries
1999 Annual Average

Figure 1



representing 8.4 percent of total non-farm employment. As Figure 1 shows, the largest employment is in computer programming and related services, followed by communications, and electronic components manufacturing.

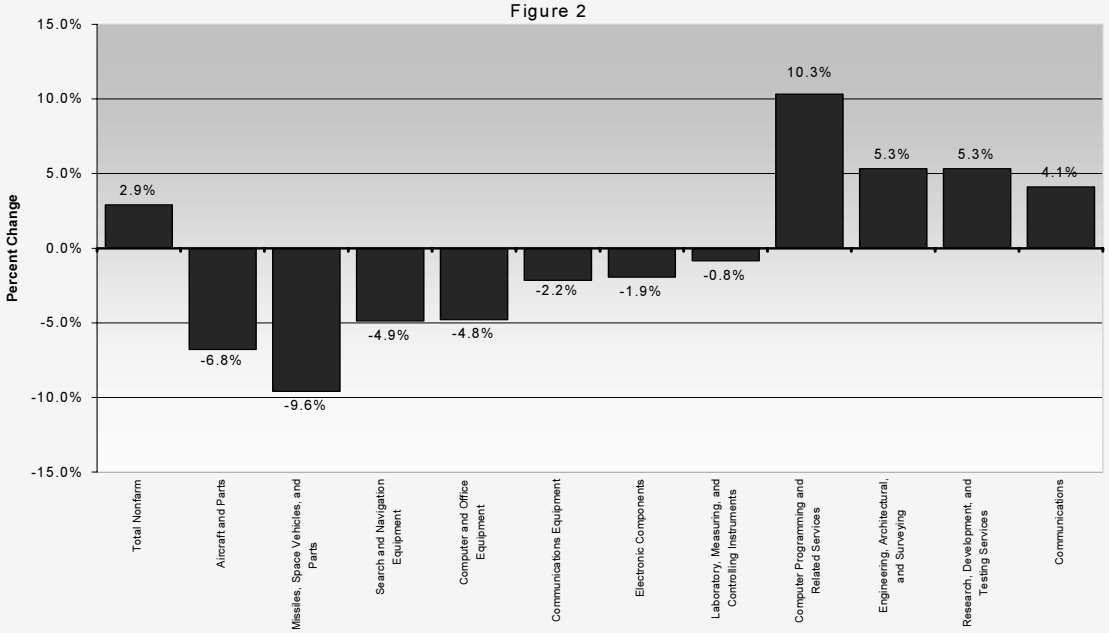
Employment in high technology industries expanded by 2.5 percent in 1999, less than job growth economy-wide, which was 2.9 percent. Growth in computer programming and related services was particularly robust, at 10.3 percent. Even with impressive economic increases in California's technology industries, employment in the manufacturing sectors continues to decline or remain relatively flat, while employment in the services industries is growing faster than growth in overall employment. (See Figure 2)

Distribution of employment in the high technology sectors varies by the size of firms within those industries. The services industries—computer programming and related services; engineering, architectural, and surveying services; and research, development and testing services—are dominated by small businesses, with 49, 64, and 41 percent, respectively, of the employment in firms with less than 100 employees. Over 77 percent of the firms in these three industry sectors have less than ten employees. Despite the fact that there are some large employers in the communications industry, three-quarters of the firms in this sector also have less than ten employees.

Occupational Staffing Patterns: Using the results of our statewide survey of occupations and wages across all industries, a table was developed to show where nine IT professional occupations are employed in the 11 high technology industries. Estimated employment in California for these IT workers in 1998 was approximately

Employment Growth in California High Technology Industries
(1998-1999 Annual Average)

Figure 2



396,000, with an estimated 234,000 (59%) of them working in the 11 specific industry groupings which we have considered the high technology industries. (See Table 1)

The industry with the highest proportion and largest number of these workers is computer programming and related services (45%, 113,000 employees).

Substantial numbers of IT professionals are also found in the industry sectors which manufacture computer and office equipment (22,300), electronic components (24,700), search and navigation equipment (12,100), and measuring and control devices (12,200). The other high tech service industries have about ten percent of their workers in these IT occupations.

Table 1

Number of Employees in Information Technology Occupations Within California High-tech Industries

October - December 1998

Occupations	High-tech Industries												Total - All Other Industries	Total - All Industries
	Computer & Office Equipment	Comm. Equipment	Electronic Components	Aircraft & Parts	Missiles, Spacecraft & Parts	Search & Navigation Equip.	Measuring & Control Devices	Communications	Computer Programming & Related Services	Engineering Services	Research Services	Total - High-tech Industries		
Electrical & Electronic Engineers	8,460	2,250	10,300	430	460	4,410	3,110	2,400	4,360	3,660	2,280	42,120	16,990	59,110
Computer Engineers	4,290	1,130	3,110	260	1,680	3,830	2,930	1,950	24,900	1,650	1,080	46,810	7,290	54,100
Electrical & Electronic Engineering Technicians	2,680	1,480	5,730	950	150	2,410	3,320	3,540	3,250	2,730	1,840	28,080	23,310	51,390
Systems Analysts	990	360	1,290	260	620	410	220	2,290	20,200	810	1,240	28,690	31,050	59,740
Computer Programmers	3,260	180	2,050	210	410	490	630	1,330	32,870	1,040	1,930	44,400	31,180	75,580
Data Base Administrators	80	40	260	50	100	100	130	250	3,190	170	340	4,710	7,680	12,390
Computer Support Specialists	2,440	320	1,600	190	260	220	900	1,750	16,430	840	1,470	26,420	31,550	57,970
Computer Programmer Aides	10	50	60	20	-	30	140	930	2,690	200	130	4,260	5,630	9,890
All Other Computer Scientists	60	100	260	170	30	220	780	20	5,090	830	750	8,310	7,440	15,750
Total - IT Occupations	22,270	5,910	24,660	2,540	3,710	12,120	12,160	14,460	112,980	11,930	11,060	233,800	162,120	395,920
Total - All Occupations	94,630	38,250	153,740	87,470	23,860	56,870	69,220	169,770	252,400	111,130	110,560	1,057,340	12,628,600	13,685,940
% of IT Workers	23.53	15.45	16.04	2.90	15.55	21.31	17.57	8.52	44.76	10.74	10.00	22.11	1.28	2.89

OCCUPATIONAL GROWTH TRENDS IN HIGH TECHNOLOGY

Occupational growth rates are forecasted by applying occupational staffing patterns for each industry collected from the Occupational Employment Statistics survey to our industry growth projections.

In general, our industry growth projections are conservative. They are based on long-term trends and do not anticipate shorter term business cycle fluctuations.

Our statewide projections for all occupations in the period 1996-2006 reflect a growth of approximately 645,000 annual job openings. Table 2 shows occupational projections for the information technology occupations. The computer professional occupations are projected to grow much faster than the nearly 25 percent growth rate of all occupations in California.

Computer engineers are projected to be among the fastest growing occupations in California from 1996-2006, with job openings growing by 118 percent. We forecast that 33,250 new jobs will be added during the projection period. Another 3,240 net replacement jobs are also expected to become available. (Net replacement jobs are made available when incumbents leave the occupation due to retirement, change of occupation, or other personal reasons.) (Annual job openings = 3,650)

Systems analysts and computer support specialists are projected to grow nearly as rapidly, with job openings growing by 112 percent and 118 percent, respectively, from 1996-2006. We forecast 47,400 systems analyst jobs

Table 2

California Projections for Selected Information Technology Occupations

Occupations	1996	2006	Growth	Net Replacement	Change in Job Openings*	1996-2006 % Change	Annual Change
Electrical & Electronic Engineers	62,470	91,130	28,660	19,340	48,000	76.8	4,800
Computer Engineers	30,930	64,180	33,250	3,240	36,490	118.0	3,650
Electrical & Electronic Engineering Technicians & Technologists	45,340	53,480	8,140	12,990	21,130	46.6	2,110
Systems Analysts	42,360	85,430	43,070	4,350	47,420	111.9	4,740
Data Base Administrators	3,940	7,900	3,960	1,180	5,140	130.5	510
Computer Support Specialists	11,150	23,080	11,930	1,170	13,100	117.5	1,310
Computer Programmers	56,260	74,170	17,910	20,300	38,210	67.9	3,820
Computer Programmer Aides	12,060	13,340	1,280	3,950	5,230	43.4	520
All Other Computer Scientists	9,170	27,560	18,390	1,250	19,640	214.2	1,960
All Occupations	12,743,400	15,872,800	3,129,400	3,322,500	6,451,900	50.6	645,190

*Change includes the sum of growth and net replacement.

and 13,100 computer support specialist jobs will be added during the projection period. (Annual job openings = 6,050)

The largest occupation in this group of information technology occupations is electrical and electronic engineers, most of who work in the manufacturing industries. (Refer to Table 1). We are projecting 4,800 annual job openings for this occupation.

The latest national occupational projections mirror California's expectations for employment growth in the computer occupations. For the period 1998-2008, computer engineers will increase by 108 percent, computer support specialists, 102 percent, systems analysts, 94 percent, and database administrators, 77 percent.

Wage Data

These computer professionals are among the highest paid employees.

Table 3 shows the hourly and annual wages earned by information technology workers and some other workers in California. These base wage rates do not reflect the widely reported signing bonuses and stock options provided to computer professionals throughout the high tech industries. Reported wages paid to newly hired workers confirms that a large percentage of high wage jobs are in the high tech industries.

Our department has begun collecting data on new hires on a quarterly basis. Table 4 shows that 235,000 out of nearly 3,000,000 workers statewide were hired in the high tech industries in the first quarter of 1999. Over 40 percent of those paid annual wages of $60,000 or more were hired by firms in these industries, and 32 percent of those paid over $48,000 also went to work in the high tech sector. Figure 3 provides a graphic breakout of the wage distribution of the 235,000 newly hired workers.

Table 3

Hourly Wages Paid to Employees in Selected Occupations
Statewide Across All Industries

Information Technology Occupations	Entry-Level Hourly Wage	Mean Hourly Wage	Mean Annual Wage	25th Percentile Hourly Wage	50th Percentile (Median) Hourly Wage	75th Percentile Hourly Wage
Electrical & Electronic Engineers	24.29	32.05	66,670	26.28	34.05	41.82
Computer Engineers	21.81	30.78	64,020	24.28	32.24	40.59
Electrical/Electronic Technicians & Technologists	12.21	19.84	41,260	14.33	18.79	23.65
Systems Analysts	18.07	27.06	56,280	20.41	26.71	36.82
Data Base Administrators	16.60	26.49	55,100	19.40	25.63	36.88
Computer Support Specialists	13.97	22.51	46,830	15.97	20.89	29.80
Computer Programmers	18.32	29.19	60,720	21.06	28.83	39.96
Computer Programmer Aides	11.68	17.95	37,340	13.16	15.86	20.55
Other Computer Scientists & Related	14.41	26.24	54,590	16.23	24.12	37.15
Other Selected Occupations						
Engineering, Mathematical & Natural Sciences Managers	28.07	38.75	80,600	31.15	41.04	53.18
Lawyers	27.49	40.35	83,920	31.32	42.52	58.16
Teachers, Secondary School	**	**	48,120	**	**	**
Registered Nurses	18.70	24.91	51,810	20.50	23.95	32.66
Salespersons, Scientific Products & Services	14.11	25.94	53,960	16.40	23.06	36.55
Carpenters	11.14	17.97	37,370	12.97	17.41	22.17
Mechanical Engineers	19.06	28.21	58,680	22.13	29.72	38.18
Biological Scientists	16.66	25.88	53,840	18.72	24.33	35.47

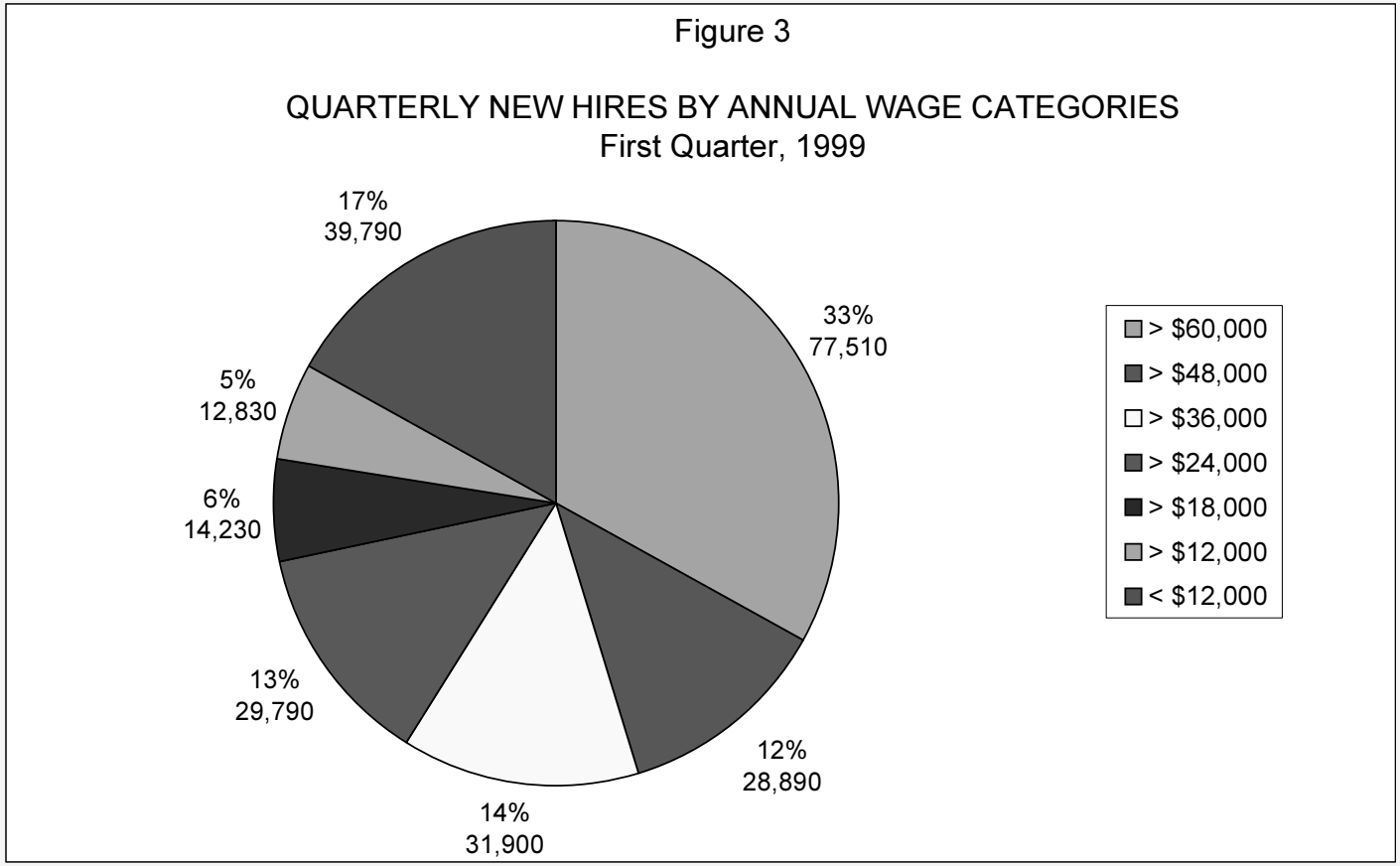
Table 4

NEW HIRES IN HIGH TECHNOLOGY INDUSTRIES
FIRST QUARTER, 1999

		QUARTERLY NEW HIRES BY ANNUAL WAGE CATEGORIES							
SIC	INDUSTRY	TOTAL	> $60,000	> $48,000	> $36,000	> $24,000	> $18,000	> $12,000	< $12,000
	TOTAL PRIVATE OWNERSHIP INDUSTRIES	**2,945,300**	**187,720**	**91,300**	**146,300**	**255,890**	**221,350**	**366,560**	**1,676,180**
	AEROSPACE MANUFACTURING	**44,730**	**15,830**	**10,720**	**7,770**	**3,860**	**1,250**	**1,030**	**4,270**
372	AIRCRAFT AND PARTS	33,210	11,050	8,920	6,100	2,940	980	750	2,470
376	GUIDED MISSILES, SPACE VEHICLES AND PARTS	2,900	1,510	550	320	220	60	60	180
381	SEARCH AND NAVIGATION EQUIPMENT	8,620	3,270	1,250	1,350	700	210	220	1,620
	ELECTRONICS MANUFACTURING	**57,670**	**28,040**	**6,010**	**6,840**	**5,810**	**3,030**	**3,150**	**4,790**
357	COMPUTER AND OFFICE EQUIPMENT	6,570	2,850	560	550	720	470	440	980
366	COMMUNICATIONS EQUIPMENT	3,710	1,540	340	510	460	250	260	350
367	ELECTRONIC COMPONENTS AND ACCESSORIES	13,660	2,750	1,100	1,490	2,170	1,680	1,900	2,570
382	MEASURING AND CONTROLLING DEVICES	33,730	20,900	4,010	4,290	2,460	630	550	890
	COMMUNICATIONS	**41,230**	**6,920**	**3,390**	**6,080**	**7,260**	**3,670**	**2,770**	**11,140**
481	TELEPHONE COMMUNICATIONS	22,710	4,370	1,560	2,810	3,690	2,070	1,590	6,620
482	TELEGRAPH AND OTHER COMMUNICATIONS	210	80	30	40	20	10	0	30
483	RADIO AND TELEVISION BROADCASTING	7,490	1,030	420	680	1,030	560	620	3,150
484	CABLE AND OTHER PAY TV SERVICES	9,910	1,210	1,340	2,470	2,410	930	480	1,070
489	OTHER COMMUNICATION SERVICES	910	230	40	80	110	100	80	270
	HIGH TECH SERVICE INDUSTRIES	**91,310**	**26,720**	**8,770**	**11,210**	**12,860**	**6,280**	**5,880**	**19,590**
737	COMPUTER AND DATA PROCESSING SERVICES	53,890	20,530	6,060	6,330	6,920	3,160	2,840	8,050
871	ENGINEERING AND ARCHITECTURAL SERVICES	23,450	3,870	1,800	3,150	3,910	2,130	2,000	6,590
873	RESEARCH AND TESTING SERVICES	13,970	2,320	910	1,730	2,030	990	1,040	4,950

Note: Private Ownership, excluding Railroads, and Private Household

Figure 3



INDUSTRY	TOTAL	> $60,000	> $48,000	> $36,000	> $24,000	> $18,000	> $12,000	< $12,000
Aerospace Manufacturing	44,730	15,830	10,720	7,770	3,860	1,250	1,030	4,270
Electronics Manufacturing	57,670	28,040	6,010	6,840	5,810	3,030	3,150	4,790
Communications	41,230	6,920	3,390	6,080	7,260	3,670	2,770	11,140
High Tech Service Industries	91,310	26,720	8,770	11,210	12,860	6,280	5,880	19,590
Total of Each Industry	234,940	77,510	28,890	31,900	29,790	14,230	12,830	39,790

EVIDENCE OF A LABOR MARKET SUPPLY PROBLEM

Recognizing the local nature of labor markets, our local partnership program, the California Cooperative Occupational Information System, is designed to study occupations selected for expected growth in employment and opportunities in training. We have compiled employer survey data on information technology occupations, mostly computer-related jobs. One of the questions asked of employers is an attempt to assess the *supply and demand* for the occupation. We ask about their experience in finding applicants for their jobs, or what is the local supply to match their demand?

In surveys of 933 firms throughout the state that employ 35,600 computer programmers, systems analysts, computer engineers, and/or software engineers, we asked how difficult it is for them to find these qualified, experienced computer professionals. *In the period 1995 through 1998, over two-thirds (69.3%) of employers surveyed reported that it was moderately to very difficult to find qualified and experienced applicants to fill these positions. In the "hardware-related" engineering and technician occupations, recruitment difficulties were reported by 72 percent of employers.*

In the same surveys, comparable difficulty was reported in finding qualified but inexperienced applicants as well. *While it is generally easier to find inexperienced workers, more than half of the 933 employers still reported that it was moderately to very difficult to find computer programmers, systems analysts, computer engineers, and/or software engineers. Similar difficulty was reported in recruiting for entry-level, or inexperienced, engineering and technician occupations.*

We also aggregated information about the data processing management and network support occupations surveyed locally around the state, such as network administrators, website designers and developers, and network managers and technicians. *In separate surveys of 467 employers who had 10,866 workers in these occupations, again, almost two-thirds (62.3%) of employers reported it was moderately to very difficult to find qualified applicants.*

While the information technology occupations stand out, our employer surveys confirm the tight labor market for a great many occupations throughout the state. In the analysis of employer responses about recruitment difficulties in all the professional, paraprofessional, and technical occupations we surveyed during the period 1995 through 1998, 57 percent reported that it was moderately to very difficult to find experienced qualified workers. This was about ten percentage points lower than was reported for the information technology occupations.

One indicator of the need for qualified information technology workers is California's heavy involvement in the program to bring in H-1B nonimmigrant foreign professionals to fill positions throughout the state. The volume of applicants is highest in the nation here in Silicon Valley. Our department provides prevailing wage determinations to employers seeking to fill openings for those computer specialists we have been describing.

We receive approximately 17,000 H-1B prevailing wage requests a year, of which over 40 percent are computer professionals or engineers. A large number of the other H-1B wage requests from high technology firms are for professionals such as market research analysts, graphic designers and management analysts. In addition, thousands more information technology workers are applying for permanent immigrant status once their temporary visas run out.

OBSERVATIONS

Based on the wage increases in high technology industries and our employer survey results, there is an increasing demand for information technology workers.

The labor market for such professionals is tight and is responding with increasing wages, and recruitment of foreign workers. Clearly, our projections indicate that the demand for such workers is rising.

At least some of the increasing demand was the result of programming needs to resolve the Year 2000 or Millennium problem. Another possible reason is that the opportunities for computer professionals to move up and start their own businesses are great. The Gartner Group, an Information Technology consulting firm, indicates that 50 to 60 percent of departing IT professionals go into business for themselves or work for an external provider. Employers are therefore competing against the general success of their industry.

On the other hand, the potential labor pool for high technology industries is supplied by students and graduates from non-technical programs. The National Software Alliance estimates that only 37 percent of programmers and other service workers are computer science graduates. The remaining 63 percent are from other fields (52%) and noncitizens (11%). Many graduates who do not have computer science credentials are hired for information technology jobs. Therefore, a simple count of graduates from technical programs such as electrical engineering or computer sciences will undercount the pool of labor available to meet industry needs.

There are other sides to the question of demand for information technology workers. As "user friendly" has become an expectation in the workplace, and high tech firms have responded, there is less need for employers to hire their own computer programmers, systems analysts, or computer engineers. They can contract for computer consultant services, and then expect their financial analysts or inventory managers or sales supervisors to use and maintain their automated management systems. Off-the-shelf or customized systems can meet the needs of much of the growing and modernizing economy. This argument notwithstanding, someone has to be able to produce the software and hardware products.

In summary, the labor market for information technology professionals is clearly tightening and is expected to tighten further. Wages are rising and opportunities for starting businesses are promising, creating wealth for the individuals in demand and consequent recruiting and placement costs for the industry.

SKILLS AND KNOWLEDGES INFORMATION FOR SELECTED INFORMATION TECHNOLOGY OCCUPATIONS

O*NET METHODOLOGY

Occupational Information Network (O*NET) is a national database of skills based on expert judgment and direct occupational surveys. This tool provides useful information on skills and knowledges.

The skills and knowledges selected for the given occupations are based on how "important" the skills or knowledges are in performing the job. Each of the skills or knowledges has a score of 80 (very important) or higher on a scale of 1 to 100. The scale measures the relative importance of the skills, knowledges, and abilities of incumbent workers in doing the jobs. The occupational data was developed from work conducted by occupational data centers located throughout the country. The ratings were assigned and validated by occupational analysts.

In general, the design of the O*NET database was developed as a skills-based structure using vocabulary from national skills standards efforts and existing Dictionary of Occupational Titles data. It offers a more comprehensive (over 400 elements per occupation) framework for exploring the world of work.

ELECTRICAL and ELECTRONIC ENGINEERS: Design, develop, test, or supervise the manufacturing and installation of electrical equipment, components, or systems for commercial, industrial, military, or scientific use. Exclude computer engineers.

SKILLS:

- Mathematics — Using mathematics to solve problems
- Science — Using scientific methods to solve problems
- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents
- Judgment and Decision Making — Weighing the relative costs and benefits of a potential action

KNOWLEDGES:

- Engineering and Technology — Knowledge of equipment, tools, mechanical devices, and their uses to produce motion, light, power, technology, and other applications

- Computers and Electronics — Knowledge of electric circuit boards, processors, chips, and computer hardware and software, including applications and programming

- Mathematics — Knowledge of numbers, their operations, and interrelationships including arithmetic, algebra, geometry, calculus, statistics, and their applications

- Design — Knowledge of design techniques, principles, tools and instruments involved in the production and use of precision technical plans, blueprints, drawings, and models

- Production and Processing — Knowledge of inputs, outputs, raw materials, waste, quality control, costs, and techniques for maximizing the manufacture and distribution of goods

- Building and Construction — Knowledge of materials, methods, and the appropriate tools to construct objects, structures, and buildings

COMPUTER ENGINEERS: Analyze data processing requirements to plan electronic data processing system to provide system capabilities required for projected work loads. Plan layout and installation of new system or modification of existing system. May set up and control analog or hybrid computer systems to solve scientific and engineering problems.

SKILLS:

- Operations Analysis — Analyzing needs and product requirements to create a design

- Mathematics — Using mathematics to solve problems

- Troubleshooting — Determining what is causing an operating error and deciding what to do about it

- Programming — Writing computer programs for various purposes

- Information Organization — Finding ways to structure or classify multiple pieces of information

- Science — Using scientific methods to solve problems

- Information Gathering — Knowing how to find information and identifying essential information

KNOWLEDGES:

- Computers and Electronics — Knowledge of electric circuit boards, processors, chips, and computer hardware and software, including applications and programming

- Engineering and Technology — Knowledge of equipment, tools, mechanical devices, and their uses to produce motion, light, power, technology, and other applications

- Mathematics — Knowledge of numbers, their operations, and interrelationships including arithmetic, algebra, geometry, calculus, statistics, and their applications

ELECTRICAL and ELECTRONIC ENGINEERING TECHNICIANS and TECHNOLOGISTS: Lay out, build, test, troubleshoot, repair, and modify developmental and production electronic components, parts, equipment, and systems, such as computer equipment, missile control instrumentation, electron tubes, test equipment, and machine tool numerical controls, applying principles and theories of electronics, electrical circuitry, engineering mathematics, electronic and electrical testing, and physics. Usually work under direction of engineering staff.

SKILLS:

- Troubleshooting — Determining what is causing an operating error and deciding what to do about it

- Testing — Conducting tests to determine whether equipment, software, or procedures are operating as expected

- Mathematics — Using mathematics to solve problems

- Active Learning — Working with new material or information to grasp its implications

- Problem Identification — Identifying the nature of problems

- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents

KNOWLEDGES:

- Computers and Electronics — Knowledge of electric circuit boards, processors, chips, and computer hardware and software, including applications and programming

- Engineering and Technology — Knowledge of equipment, tools, mechanical devices, and their uses to produce motion, light, power, technology, and other applications

- Design — Knowledge of design techniques, principles, tools and instruments involved in the production and use of precision technical plans, blueprints, drawings, and models

- Mathematics — Knowledge of numbers, their operations, and interrelationships including arithmetic, algebra, geometry, calculus, statistics, and their applications

SYSTEMS ANALYSTS: Analyze business, scientific, and technical problems for application to electronic data processing systems. Exclude persons working primarily as engineers, mathematicians, or scientists.

SKILLS:

- Troubleshooting — Determining what is causing an operating error and deciding what to do about it

- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents

- Programming — Writing computer programs for various purposes

- Testing — Conducting tests to determine whether equipment, software, or procedures are operating as expected

- Problem Identification — Identifying the nature of problems

- Operations Analysis — Analyzing needs and product requirements to create a design

- Writing — Communicating effectively with others in writing as indicated by the needs of the audience

- Implementation Planning — Developing approaches for implementing an idea

KNOWLEDGES:

- Computers and Electronics — Knowledge of electric circuit boards, processors, chips, and computer hardware and software, including applications and programming

- English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar

DATA BASE ADMINISTRATORS: Develop, test, and coordinate changes to computer databases, applying knowledge of database management systems. May plan, coordinate, and implement security measures to safeguard computer databases.

SKILLS:

- Programming — Writing computer programs for various purposes

- Mathematics — Using mathematics to solve problems

- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents

- Operations Analysis — Analyzing needs and product requirements to create a design

- Instructing — Teaching others how to do something

- Technology Design — Generating or adapting equipment and technology to serve user needs

- Testing — Conducting tests to determine whether equipment, software, or procedures are operating as expected

- Information Organization — Finding ways to structure or classify multiple pieces of information

- Problem Identification — Identifying the nature of problems

KNOWLEDGES:

- Computers and Electronics — Knowledge of electric circuit boards, processors, chips, and computer hardware and software, including applications and programming

COMPUTER SUPPORT SPECIALISTS: Provide technical assistance and training to system users. Investigate and resolve computer software and hardware problems of users. Answer clients' inquiries in person and via telephone concerning the use of computer hardware and software, including printing, word processing, programming languages, electronic mail, and operating systems.

SKILLS:

- Troubleshooting — Determining what is causing an operating error and deciding what to do about it
- Testing — Conducting tests to determine whether equipment, software, or procedures are operating as expected
- Instructing — Teaching others how to do something
- Problem Identification — Identifying the nature of problems
- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents
- Critical Thinking — Using logic and analysis to identify the strengths and weaknesses of different approaches
- Information Gathering — Knowing how to find information and identifying essential information
- Judgment and Decision Making — Weighing the relative costs and benefits of a potential action
- Product Inspection — Inspecting and evaluating the quality of products

KNOWLEDGES:

- Computers and Electronics — Knowledge of electric circuit boards, processors, chips, and computer hardware and software, including applications and programming

COMPUTER PROGRAMMERS: Convert project specifications and statements of problems and procedures to detailed logical flow charts for coding into computer language. Develop and write computer programs to store, locate, and retrieve specific documents, data, and information.

SKILLS:

- Programming — Writing computer programs for various purposes
- Writing — Communicating effectively with others in writing as indicated by the needs of the audience
- Reading Comprehension — Understanding written sentences and paragraphs in work-related documents
- Critical Thinking — Using logic and analysis to identify the strengths and weaknesses of different approaches
- Information Organization — Finding ways to structure or classify multiple pieces of information
- Problem Identification — Identifying the nature of problems
- Active Listening — Listening to what other people are saying and asking questions as appropriate
- Active Learning — Working with new material or information to grasp its implications

KNOWLEDGES:

- Computers and Electronics — Knowledge of electric circuit boards, processors, chips, and computer hardware and software, including applications and programming
- Mathematics — Knowledge of numbers, their operations, and interrelationships including arithmetic, algebra, geometry, calculus, statistics, and their applications